THE

BRITISH

PLEISTOCENE MAMMALIA.

BY

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PART V.

BRITISH PLEISTOCENE OVIDÆ.

OVIBOS MOSCHATUS, BLAINVILLE.

(PAGES 1—30; PLATES I—V.)

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1872.

PRINTED BY

J. E. ADLARD, BARTHOLOMEW CLOSE.

MONOGRAPH

ON

THE BRITISH MAMMALIA

OF THE

PLEISTOCENE PERIOD.

Order—UNGULATA.

Sub-order—*ARTIODACTYLA.*

Family—OVIDÆ.

Genus—Ovibos.

Species—*Ovibos moschatus*, Blainville.

CHAPTER I.

§ 1. *Introduction.* | § 2. *Zoology.*
§ 3. *Habits and present Range.*

§ 1. *Introduction.*—*Ovibos moschatus*, more commonly known as the Musk Ox of North America, has been described by naturalists under various names, as their opinions fluctuated concerning its affinities to the Oxen, Buffaloes, or Sheep. It is called the Bœuf Musqué by its original discoverer in Hudson's Bay, M. Jeremie,[1] by Drage,[2] Dobbs,[3] Ellis,[4] Hearne,[5] and all the arctic explorers of the present century. Under this name it was first systematically described by our countryman Pennant,[6] who also gives an admirable figure of the male and female, as well as by Buffon. It is described under the name of *Bos moschatus* by Gmelin,[7] Zimmermann,[8] Schreber,[9] Blumenbach,[10]

1 'Voyage au Nord,' t. iii, p. 314.
2 'Voyage,' vol. ii, p. 260.
3 'Hudson's Bay,' pp. 19, 25.
4 'Voyage,' p. 232.
5 'Journey A.D. 1770, 1772,' 4to, pp. 135-9.
6 'Arctic Quadrupeds,' vol. i, p. 8, pl. ii (A.D. 1784). See also his 'History of Quadrupeds,' published in 1781, in which he speaks of it as a Musk Buffalo, vol. i, p. 27.
7 Lin., 'Syst. Nat.,' ed. Gmelin, i, p. 205.
8 'Geograph. Gesch.,' ii, p. 26.
9 'Saügethiere,' 302.
10 'Handb.,' 10, pp. 122-6.

Shaw,[1] and Cuvier,[2] by whom it was also termed "Le Buffle Musqué." M. de Blainville,[3] on the other hand, considering the animal intermediate in character between the Sheep and the Ox, proposed the name of *Ovibos moschatus*, which was adopted by Desmarest,[4] Sir John Richardson,[5] and more lately by the great French Palæontologist M. Lartet,[6] while Professor Owen[7] believes that the animal has been subgenerically separated without due grounds from the other Bubali, and especially from the Cape Buffalo (*Bubalus Caffer*), and therefore figures and describes the animal under the name of *Bubalus moschatus*. To settle this conflict of opinion as to its true place in the zoological scale is the object of the following analysis of its affinities, as well as to define the range of the animal in space and in time, and to collect together all the evidence of its sojourn in this country during the Pleistocene age. The two remarkable, allied forms discovered in the United States, and described by Professor Leidy under the name of Bootherium,[8] add considerably to the interest of an investigation into the characters of Ovibos. Before, however, we discuss any of these questions, it will be necessary to enter very briefly on the natural history of the animal.

§ 2. *Zoology*.[9]—The *Ovibos moschatus* about equals in size the small Welsh and Scotch cattle. The head is large and broad, and the nostrils are oblong, inclining towards each other from above downwards, with the inner margins covered with short bristles, and joined together at their bases by an interspace of about an inch. The rest of the end of the nose, the middle part of the upper lips, and the greater part of the lower lips and chin, are covered with close, short, yellowish-white hairs; the upper lip is furrowless, and there is no trace of a muffle. These points alone would be sufficient to separate the animal from the Bos and Bubalus, and relegate it to the ovine or caprine group of Mammals. The ears are small, as in the Yak, being three inches in length, erect and pointed, dilated in the middle. The dark umber-brown hair on the middle of the forehead is long and erect, on the cheeks smooth and pendulous, and forming with that on the throat a long beard. The horns are closely united in the old bull in the median line, and cover the brow and whole crown of the head with their bases. Each passes downwards between the eye and the ear until it reaches the plane of the mouth, when it turns upwards and forwards, and ends in the same plane as the eye. Their basal halves are of a dull white colour, oval in section and coarsely fibrous, their middle smooth and shining,

[1] 'General Zool.,' ii, p. 407.
[2] 'Oss. Foss.,' iv, p. 133, et seq.
[3] 'Bull. Soc. Philomat.,' 1816, pp. 76 et 81.
[4] 'Mammalogie.'
[5] 'Fauna Borealis Americana,' vol. i (1829), and 'Zool. of H.M.S. Herald' (1852).
[6] 'Comptes Rendus,' vol. lviii, 26.
[7] 'Quart. Geol. Soc. Journ.,' vol. xii, pp. 136, 137.
[8] 'Smithsonian Contributions to Knowledge,' vol. v, 1852.
[9] The authorities which are the basis of this description are Pennant, Hearne, De Blainville, and especially Sir John Richardson, tested by an examination of the species in the British Museum. In the works of the latter the skeleton is admirably described. See 'Zoology of H.M.S. Herald.'

their tips black. The length of those belonging to the skeleton in the British Museum is twenty-seven inches, following the curvature. In the yearling male, and the female throughout life, they are small and separated by a space from each other, present a curvature outwards and downwards, and are more cylindrical than in the male in the prime of life. A similar difference in the horn development, depending upon the age and sex, is observable in the Gnu, which also closely approaches the Musk Sheep in other points of the skull. The hair on the throat and chest is long and straight, and together with that on the lower jaw hangs down like a beard or dewlap. This is shorter in the female than in the male. The neck is short and covered with long matted curly hair of a dull grizzled brown colour; it stands erect between the shoulders, and gives the appearance of a hump, as in the Yak. On the back and hips it is very long, but lies smoothly. From the shoulder, sides, and thighs, it hangs down as far as the middle of the leg. In the middle of the back it is of a lighter colour and not so long. The tail, three inches in length, is entirely concealed by the long hair of the hips. Its shortness is a character which would differentiate the animal from the Bos, Bubalus, and Bison. The body is defended from the cold by a clothing of fine brownish ash-coloured wool, which, according to Hearne, falls off in the summer. It was from this wool that M. Jeremie had gloves woven which were as soft and glossy as silk. It is not present on the legs. These latter are short and stout, terminated by unsymmetrical hoofs, the external being rounded, the internal pointed; the soft frog is partially covered with hair; the animal, as its name denotes, smells of musk. The number of its teats is two instead of four, and it has no dewlap,[1] two points in which it is separated from the Bos, Bubalus, and Bison, and closely allied to the Sheep. The dung also differs most remarkably from that of those animals, assuming the form of round pellets indistinguishable except in size from that of the Caribou[2] and the Alpine Hare.[3] The period of gestation is, however, nine months, as in the true Oxen; they take the male in August, and bring forth their young in the end of May or beginning of June.

The following measurements of animals killed by Lieut. McClintock, on Melville Island, taken from p. 87 of the 'Zoology of H.M.S. Herald,' enables us to realise the size of the animal. They are taken in inches and tenths. The weight of the males killed on that island exceeded 700 pounds, of which 400 was meat, and they stood 10½ hands high at the withers, or 42 inches.

	Musk Bull.	Musk Cow.	Musk Cow.	Musk. Cow.
From horns to the root of tail . . .	86·0	70·5	64·0	62·0
From the fore hoof to the top of the shoulder .	57·0	55·0	—	49·5
From the hind hoof to the top of the rump . .	51·0	—	—	—
Length of tail	2·0	—	—	—
Length of one horn	27·0	24·0	—	19·0
From the tip of one horn to that of the other .	32·0	27·3	—	27·5

[1] Sir John Richardson. [2] De Blainville. [3] Hearne.

In this brief *résumé* of the external characters of Ovibos, the truth of M. de Blainville's views as to its place in the scale between Ovis, on the one hand, and Bos on the other, is most amply proved. In addition to the absence of a muffle and of a dewlap, on which his classification is principally based, the hairiness of its nostrils, the shortness of its tail, the want of symmetry in its hoofs, differentiate it from all the Oxen, Bisons, and Buffaloes, and especially from *Bubalus Caffer*, to which it bears a mere superficial resemblance in the large size and downward direction of the horns, and the close approximation of their bases in the adult males. In these points also it has a still closer resemblance to the Gnu or Wildebest of the Cape, as well as in the long hair on its chin and neck, and the erect hair between its shoulders, while its smallness of ear, shortness of tail, and want of symmetry of hoof, are among the differences.

§ 3. *Habits and present Range.—The Ovibos moschatus* at the present day is confined to the North-American continent, where it ranges over the treeless barren grounds from the river Mackenzie, through 105 degrees of longitude, along with Eskimos, Reindeer, Wolvereenes, Bears, and various species of Lemming, Spermophilus, and Hare. The Mackenzie is its western limit according to Sir John Richardson; but as Capt. Beechey found that it was known to the Eskimos near Eschscholtz Bay, it probably ranges considerably further westward. Its southern limit is a line drawn along the edge of the woods "from the entrance of the Welcome into Hudson's Bay, about the 60th parallel of latitude, in a westward and northward direction, to the 66th parallel at the north-east corner of Great Bear Lake, and from thence ranging in the same direction to Cape Bathurst, in the 71st parallel." In the last century it ranged a degree further southwards, being found by Hearne, the enterprising explorer of the Copper Mine River, in 1769, a little to the north of Churchill, in lat. 59°. North of this line it is found throughout the barren grounds as far as the shores of the Arctic Sea. From the main land it comes over to the islands north and east, since Capt. Parry and Lieut. McClintock killed several of them on Melville Island, lat. 75°. It is gregarious in habit, the herds, according to Mr. Hearne, amounting sometimes to eighty or a hundred head, in which there are seldom more than two or three full-grown males. They delight in the most stony and mountainous parts, and climb rocks with great facility, being as sure-footed as the goat. They seem fondest of grass; but when they cannot get that in the winter, they feed on moss, the tops of the willows, and the tender branches of the pine trees. They are able to bear all the severity of an arctic winter, the large quantity of dung, observed by Mr. Hearne on the snow at the mouth of the Coppermine, proving that the locality had been inhabited by them during the winter of 1770-1. Generally, however, in common with the Caribou and other arctic Mammals, their migrations are regulated by the season, and they do not remain in the same place throughout the year. They are not found in Greenland or Spitzbergen.

CHAPTER II.

Osteology.

§ 1. *Skull.*
§ 2. *Limbs.*
§ 3. *Place of Ovibos in classification.*
§ 4. *Measurements.*

§ 1. *Skull.*—We have seen that *Ovibos moschatus*, in its external characters, approaches the Sheep and Goats more closely than any other Mammals; an examination of its skeleton confirms its ovine and caprine affinities, and proves how far aloof it stands from Bos, Bison, and *Bubalus Caffer*.

The basi-occipital bone in *Ovibos moschatus* (Pl. I, fig. 1) is quadrate in outline, with the sides roughly parallel, so that the area included between the anterior (*c*) and posterior (*d*) muscular impression is bounded on each side by a line roughly parallel (fig. 2) to the median line; the anterior impressions also are oval, and are not supported on a tuberosity, as in the Oxen. In the Argali, or Big-horn (fig. 4), and all the Sheep that have passed through my hands, this quadrate definition is more or less clearly marked. In *Bos taurus*, *Bison Americanus*, and *Catoblepas Gnu*, the two sides of the bone converge and give it a truncated triangular form, which reaches a maximum in *Bubalus Caffer* (fig. 3). In *Bos taurus* also the anterior muscular impressions are supported on long tuberosities. The basisphenoid is shorter, thicker, and stouter than in Bos, Bison, or Bubalus, and is untraversed by a median ridge, which is strongly marked in all these three animals.

The palatal surface of the palatines and maxillaries is more concave transversely than in the Ox, Buffalo, and Bison, and much longer in proportion to its width. The palate tapers gradually to the anterior edge of the premaxillaries, making but a slight detour round the anterior palatal foramen, instead of presenting the broad spatulate terminations seen in all these three genera. All these are decidedly ovine and caprine characteristics. In the Gnu the concavity and length of palate is united with the spatulate termination of the premaxillaries. The large space that the palatines of Ovibos take in the palate points to a bovine affinity. The paramastoid (Pl. II, *e*) process tapers gradually to its apex in Ovibos and the Sheep; in *Bubalus Caffer* the latter is enlarged.

The occiput (see Pl. II) is remarkable for its height, flatness, and the strong development of the occipital crest and nuchal spine. The supra-occipital encroaches on the coronal aspect of the skull, where it articulates with the parietals and the wormians, the

occipito-parietal suture between them remaining unobliterated,[1] which two characters are never seen in the adult Bos, Bubalus, or Bison. The share which the mastoids take in the formation of the occiput is much smaller than in any of those three animals, and hence its greater height in proportion to its width. In *Bubalus Caffer* the width reaches a maximum. The occipital crest is much more strongly marked in Ovibos, Capra, and Ovis, than in any of the three animals so frequently quoted.

Coronal Surface.—We have now to discuss the most important portion of the skull, the coronal surface, which in the old male (Pl. III) is almost concealed by the large spongy bases of the horncores. In the young animal,[2] in common with all the cavicorn ruminants, the Gnu and Giraffe excepted, they are supported by the frontals, while in the old male they extend far back over the parietals, and project over the occipital surface. In the Giraffe the paired horncores are situated on the parieto-frontal suture; in the old male Gnu they extend over the suture, as in Ovibos. Each horncore in the last animal is separated from its fellow by a diastema in the median line, varying in width according to sex and age, the diastema being smallest in the old male (Pl. III), and largest in the young female (Pl. IV, fig. 1). Each (*g*) is raised above the coronal surface, in the adult (Pl. III) male at least 0·8 inch; thence it passes horizontally outwards, decreasing in size as far as a line passing in front of the orbit, where it turns suddenly downwards at a right angle, and ends in a stout obtuse point that extends further down than the tips of the paramastoid process. The fossil skull figured is an admirable example of this (Pl. III). In the female (Pl. III) the horncores are much smaller and more cylindrical than in the adult males, and they are supported by the frontal bone, as in the female Gnu.

The structure of the horncores affords a character of very great importance in the determination of the affinities of the animal. The section made of the horncore in the College of Surgeons (3817) proves that it consists of a compact spongy mass, solid for at least an eighth of its length, and with a simple vacuity merely at its base. That this character is constant is proved by the section of the fossil horncore from Crayford, as well as by the observations of M. Lartet.[3] In Bos, Bison, and Bubalus, the frontal sinuses are prolonged as far as the end of the horncores,[4] while in Ovis and Capra they are never prolonged further than the middle, and very frequently they do not enter the horncores at all, as in some of the Antelopes. In the compactness, then, of its horncores, as M. Lartet has observed, *Ovibos moschatus* is allied to Ovis, while in their position on the parietal in the old male it stands apart from all these genera. Among the points of difference between

[1] See 'Manuscript Cat. of Osteological Series in the University Museum, Oxford.' I have to thank Professor Rolleston, F.R.S., for calling my attention to this character.

[2] 'See 'Zoology of Herald,' pl. iv.

[3] Op. cit.

[4] I have, however, seen two horncores of *Bison priscus* which are solid for a distance of at least six inches from their tips. They are altogether exceptional in character, and may have been diseased.

Ovibos and *Bubalus Caffer* is the enormous development of the frontal sinuses in the latter, which causes the coronal surfaces to assume the form of a segment of a circle antero-posteriorly, while in the former the corresponding surface is but slightly curved.

The Facial Aspect.—Running transversely across the parietals at a short distance above the orbit, is a stout bony ridge (Pl. III, *i*) or step, which is peculiar to the old male Ovibos. The fronto-nasal suture extends nearly at right angles to the median line, instead of being directed obliquely forwards at a very acute angle, as in the Ovis, Capra, Bos, and especially *Bubalus Caffer*. In the European Bison it runs at a slightly greater angle than in the Bovidæ, and then suddenly ends in a right angle with the median line, while in the American it is straight throughout. The nasal bones are much wider posteriorly than anteriorly, and their anterior extremities are much narrower than in the Bovidæ, two points in which they approach Ovis and Capra. The premaxillaries are slender, and their sides converge anteriorly, as in the Goats and Sheep, while in Bubalus, Bos, and Gnu, they are nearly parallel. They do not extend, as in Bos, as far back as the nasals, a character which they share with the Bison. They end in a small rounded extremity. The facial plate of the maxillary is much more vertical in Ovibos and Ovis than in Bos, Bubalus, or Bison, and the facial ridge is represented by a stout boss above the root of the first true molar, as in *Bubalus Caffer*. The lachrymal bone also has a strong ovine character impressed upon it in the broad deep excavation in front of the orbit. In the female skull in the College of Surgeons it is very shallow, in the two skulls of old males in the same collection very broad and deep. In the majority of the Antelopes, as the Gnu, in common with the Oxen, Bison, and Buffalo, this is absent; in others, however, as the Bontebock and the Eland, it is also found.

Orbits.—The outward projection of the orbits differentiates most strongly Ovibos from the true Bovidæ, and especially from *Bubalus Caffer*. In the Bison, however, the same character is found, and is more developed in the European than in the American species. This is a decided ovine affinity. A reference to the table of measurements will give the comparative projection of the orbits in all the mammals quoted in this essay.

Summary of Head.—In fine, the whole contour of the skull of *Ovibos moschatus,* in its tapering forwards, in the prominence of its orbits, in the verticality of the facial plate of the maxillary and the lachrymal excavation, prove that the animal is more closely allied to the Sheep than to any other of the Mammalia. The analysis of the different bones of the skull proves that it is separated further from *Bubalus Caffer* than from the true Oxen or the Bisons. It approaches the Gnu nearer than any of the large cavicorn ruminants, though the following points of difference are found in the latter: the occiput is broader than high, basisphenoid keeled, premaxillary palatal surface spatulate and expanded, premaxillaries articulate with nasals; thus, although there is a superficial resemblance to Ovibos in this animal, in those points which have been enumerated in the description of the skull of the former, it is overborne by more important differences.

Teeth.—The ovine and caprine affinities visible in the skull of the Musk Sheep are visible also in the teeth; the upper true molars are differentiated from those of Bison and Buffalo by the sharpness, stoutness, and prominence of the three principal costæ on their outer surface, and the small development of the two secondary ones. The crowns also of the teeth are not so broad. On the internal aspect there is no accessory column, a point which would at once separate them from Bos, Bubalus, and Bison. There is a small accessory valley at the inner interspace between the two principal ones, which is present also in *Bos Caffer*. It is absent from many of the Oxen, and is in the Musk Sheep invariably larger and deeper than in any of the true Bovidæ. A strong process passes from the inner side of the valley in premolar, and diagonally backwards as far as its external border. The anterior edge of the first premolar (P. M. 2) is much sharper than in any of the Bovidæ, and differs in the simplicity of its crown from that of *Bubalus Caffer*. The lower jaw teeth differ from those of Oxen in the length of the anterior costa, and by its being continued past the cingulum, by the fusion of the posterior valley in molar 3 with the second, and by the narrowness of the teeth. In premolars 4 and 3, also, the posterior lobe is much more clearly defined. In other respects the lower dentition is closely allied to that of the domestic Ox. The form of the lower jaw is essentially ovine or caprine, differing from those of Ox and Bison in the proportions which are given in the measurements.

§ 2. *Vertebræ.*—The vertebræ have been described and figured so admirably by Sir John Richardson in the 'Zoology of the Herald,' pp. 72—89, that all that is necessary to be said about them here is, that their zoological evidence agrees with that of the rest of the skeleton. They consist of seven cervicals, thirteen dorsals, six lumbars, six sacrals, and six caudals.

Scapula.—The scapula, in common with that of Ovis, differs from that of Ox in the straightness of its spine, in the curvature of the dorsal edge, and the small size of the crown.

Humerus.—The humerus presents the following ovine characteristics:—The deltoid ridge is smaller and less everted, the superior tuberosity is more massive, and the ridge running from the deltoid to the outer side of the proximal articulation is less marked than in the corresponding Ox bone; the bone itself is also more slender.

Radius.—The radius presents the following differences from that of Bos:—The tuberosity on the exterior of the proximal end is further removed from the articulation, and the bone itself is smoother and rounder, the muscular impressions are not so strongly marked.

Ulna.—The superior surface of the olecranon is rounded; and is much shorter than in Bos or Bison, in which it ends in a sharp ridge; the transverse diameter of the proximal articulation is also greater; the groove at the point of anchylosis with the radius is also absent; all these are ovine and caprine characters.

Metacarpal.—The metacarpal is shorter and stouter than that of Ox, its dorsal surface bears the merest trace of an extensor groove; the synovial cavity between the articulations

with the magnum and unciform is very much smaller, and the posterior edge of the proximal articulation consists of two planes meeting one another at a very obtuse angle instead of being straight. In this respect it agrees with Ovis, but it is very much shorter and stouter than the corresponding bone in that animal.

Phalange 1.—The first phalange is more slender than that of Ox. On the palmar surface the muscular ridges circumscribe a broad groove, and there is a deep excavation immediately above the distal articulation; it differs from Ovis in this latter character, and also in its greater stoutness.

Phalange 2.—The second phalange is defined from Bos and Ovis by the deep excavation in the palmar surface, which occupies the whole of the shaft; it is much stouter than in Ovis.

Phalange 3.—The hoof phalange differs from that of Ox in the articulation not extending to the superior surface of the bone; the palmar surface is more oblique than in Ox, and is not defined from the inner surface, as in that animal and the Sheep.

Pelvis.—The crest of the ilium forms an arc of a circle, while in Ox it is hollowed superiorly. The spine of the ischium is not so pronounced as in the Ox, nor is the spine on the symphysis pubis so strongly marked; the anterior edge of the pubis is straight. All these points characterise Ovis and Capra.

Femur.—The head of the femur is more clearly defined from the articular surface of the interspace between it and the great trochanter than in Bos and Bison; the latter is narrower and the cavity is deeper; the smaller trochanter is mastoidal in shape, the shaft is flatter on its dorsal surface and rounder, especially at its distal end; the inner edge of the patellar articulation is sharp instead of being rounded off, as in Ox and Bison, it is sharper even than in Ovis. All these are ovine and caprine characters.

Tibia.—The slenderness of shaft and internal malleolus, roundness of the articular surface between the inferior edges of the two femoral articulations, are ovine characters; the internal groove also on its inferior surface is slightly incurved, distally, while in Bos, Bison, and Cervus, it is straight.

Metatarsal.—The metatarsal, in its stoutness and breadth, especially of the condyles, differs from both Ovis and Bos; in the shallowness of extensor groove, and its absence from the distal third of the shaft, it resembles the former and differs from the latter animal. Its proximal facets are altogether ovine.

Hind phalange 1 differs from that of Bos by the greater flatness of its dorsal surface, by the presence of a dorsal pit above the distal articulation, and by the flat palmar area being bounded on either side by a ridge; it is stouter than that of Sheep.

Hind phalange 2.—The second phalange is shorter than in the Sheep, and more slender than in the Ox; the muscular impression on the side of the proximal articulation that faces the corresponding phalange of the foot is stouter than in Sheep or Oxen; and rises into a tuberosity which is altogether absent from the latter; the palmar surface of the shaft is excavated more deeply than in Bos or Ovis.

Phalange 3.—The articulation extends downwards nearer the palmar surface of the bone than in Ox or Sheep; in the former it is deeper than broad; the description is the same as that of the hoof phalange of the fore leg.

§ 3. *Place in Classification.*—The evidence, therefore, of its ovine affinities afforded by the external characters of the animal is proved to demonstration by its osteology. It is separated from Ovis by many characters which have been enumerated, and especially by the share which the parietals take in supporting the horns of the old male, and by the presence of a transverse ridge on the frontals in the old male, as well as by the large size of the animal and its period of gestation of nine months. In no respect has it any relation to *Bubalus Caffer*. In the zoological scale it stands, as M. de Blainville wrote in 1816,[1] between Ovis on the one hand and Bos on the other, being more closely related to the former than the latter, and being separated from the closely allied family of Capridæ, by the downward direction of the horns and their closeness to the head.

§ 4. *Measurements.*—The following tables of measurement, taken in inches and tenths, show at a glance the relation which the recent holds to the fossil Ovibos, and the enormous difference between that animal and the Buffaloes, Oxen, and Bisons. From the first table the measurements of the fossil skull, described by Pallas and Ozeretzkowsky, have been purposely excluded, because of the uncertainty as to whether they employed the French, English, or Russian inch, Cuvier taking one view and Sir John Richardson another. The terms of measurement of the pelvis and several of the other measurements are taken from the work of Sir John Richardson so often referred to.

In the table of measurements of teeth, No. 1 is the antero-posterior extent; No. 2, the antero-transverse diameter; No. 3, the postero-transverse; and all are taken at the base. In the last lower molar there is an additional transverse measurement for the additional lobe.

In the measurements of long bones the following numbers are used throughout:

1. = Maximum length.
2. = Minimum circumference.
3. = Transverse measurement of proximal articulation.
4. = Vertical ditto.
5. = Transverse measurement of distal articulation.
6. = Vertical ditto.

[1] Op. cit., Genus, xi.

Comparative Skull Measurements.	Male musk sheep, Brit. Museum.	Female musk sheep, Coll. Surg.	Male musk sheep, Sir John Richardson.	Female ditto.	Male musk sheep, 381, Coll. Surg., described by Sir J. Richardson.	Male musk sheep, Crayford (Pls. ii, iii, iv).	Male musk sheep, Maidenhead.	Male musk sheep, Freshford.	Female musk sheep, Freshford (Pl. v).	Female musk sheep, Escholtz Bay.	Bubalus Caffer, British Museum.	Bos taurus, British Museum.	Bison Europæus, Brit. Museum.	Bison Americanus, Brit. Museum.	Catoblepas gnu, Coll. Surgeons.	Caprovis argali, Brit. Museum.	Caprovis montana, Brit. Museum.	Bootherium bombifrons, Leidy.	Bootherium cavifrons.
Basal length of skull	18·0	...	...	...	19·5	...	...	...	...	...	18·2	20·8	18·3	19·0	14·2	12·9	11·3	...	...
Length of basi-occipital and basi-sphenoid	4·3	3·2	4·2	4·0	...	5·0	...	...	...	...	4·2	5·8	4·6	4·45	3·4	3·2	3·15	...	...
Breadth of posterior muscular impression on basi-occipital	2·3	2·0	2·3	2·3	...	2·8	...	...	...	...	3·6	2·5	2·5	2·72	2·06	1·9	1·65	...	...
Breadth of anterior muscular impressions	2·1	1·6	2·0	2·0	...	2·8	...	...	...	...	1·3	1·35	1·45	1·3	1·1	1·9	1·7	...	...
Breadth of basi-sphenoid close to presphenoidal articulation	0·8	0·76	0·7	0·7	...	0·8	...	...	...	...	0·75	0·7	0·85	0·95	0·4	0·5	0·45	...	...
Length of palatines.....	3·0	...	...	...	2·1	...	...	...	...	...	2·8	3·4	3·0	3·5	1·15	0·7	0·8	...	...
„ maxillaries	4·0	...	...	...	5·3	...	...	...	...	...	4·5	4·8	4·0	4·0	3·14	3·14	2·72	...	...
„ premaxillaries.....	4·0	...	...	...	4·0	...	...	...	...	...	4·0	4·9	4·6	4·4	3·65	2·9	2·55	...	...
Breadth of palate behind last true molar	3·4	3·4	3·3	3·2	3·4	...	...	...	...	...	3·7	4·0	4·0	4·5	2·19	2·2	2·0	...	...
Breadth of palate in front of first premolar	2·4	...	2·3	2·2	2·3	...	...	...	...	...	3·6	3·8	2·7	3·35	1·55	1·3	1·25	...	...
Breadth of anterior edge of premaxillaries	1·2	...	...	...	1·3	...	...	...	...	...	4·5	4·2	2·7	3·6	2·9	1·0	1·45	...	...
Molar breadth (exclusive) ...	5·5	5·0	...	...	4·6	...	...	...	...	...	8·0	7·0	9·2	8·0	0·5	4·7	4·4	..	...
Glenoid breadth (inclusive)...	6·0	5·25	...	...	6·8	...	...	...	...	...	7·5	9·0	7·0	7·8	5·5	5·5	5·2	...	...
Paramastoid breadth (inclusive).....	5·25	...	...	...	5·8	...	...	...	...	...	5·4	5·3	5·3	5·3	3·5	4·3	3·6	...	...
Height of occiput	4·5	4·0	5·0	4·5	4·9	5·8	4·5	...	...	...	4·4	7·25	5·4	5·8	3·8	2·6	2·9	...	...
Breadth of occiput	7·0	...	6·7	6·0	7·5	7·+	...	...	...	...	10·0	11·0	9·8	9·8	5·4	5·0	3·5	...	...
Breadth of foramen magnum in middle.....	1·25	...	...	...	1·5	1·5	...	...	...	...	1·8	1·8	1·3	1·1	1·05	1·2	1·3	...	...
Breadth of foramen magnum at top	1·5	...	...	...	1·8	1·3	...	...	...	...	2·5	2·25	1·5	1·5	1·25	1·3	1·13	...	...
Breadth of foramen magnum at bottom.....	0·4	...	...	...	0·5	0·4	...	...	...	...	0·67	0·45	0·5	0·4	0·4	0·56	0·2	...	...
Transverse measurement of condyle	1·5	...	...	...	2·05	1·9	1·8	...	...	...	1·9	2·0	2·3	2·5	1·5	1·0	1·0	...	...

Comparative Skull Measurements (*continued*).	Male musk sheep, Brit. Museum.	Female musk sheep, Coll. Surg.	Male musk sheep, Sir John Richardson.	Female ditto.	Male musk sheep, 381, Coll. Surg., described by Sir J. Richardson.	Male musk sheep, Crayford (Pls. ii, iii, iv).	Male musk sheep, Maidenhead.	Male musk sheep, Freshford.	Female musk sheep, Freshford (Pl. v).	Female musk sheep, Escholtz Bay.	Bubalus Caffer, British Museum.	Bos taurus, British Museum.	Bison Europæus, Brit. Museum.	Bison Americanus, Brit. Museum.	Catoblepas gnu, Coll. Surgeons.	Caprovis argali, Brit. Museum.	Caprovis montana, Brit. Museum.	Bootherium bombifrons, Leidy.	Bootherium cavifrons.
Vertical measurement of condyle	2·9	...	...	...	...	2·9	2·2	...	...	...	3·1	4·2	3·0	3·05	1·8	2·2	3·2	...	...
Occipital crest to fronto-nasal suture	11·2	7·6	...	...	13·8	...	...	...	...	...	11·8	10·5*	10·5*	10·2*	8·5*	7·5*	8·4	...	...
Fronto-nasal suture to tip of nasals	5·9	...	...	...	6·2	...	...	...	...	...	8·1	7·9	6·9	7·5	6·35	9·2	5·6	...	...
Frontal breadth between orbits	8·6	6·8	...	...	9·8	8·8	...	...	...	...	7·5	7·5	10·8	9·4	4·1	9·0	5·9	...	...
Frontal breadth at naso-frontal suture	3·4	2·5	...	...	3·4	...	...	...	...	...	4·4	6·0	6·0	6·0	2·4	4·5	2·5	...	...
Posterior breadth of nasals	3·0	...	...	...	3·3	...	...	...	...	...	2·5	2·7	3·65	4·0	0·6	3·2	2·8	...	...
Anterior breadth of nasals at maxillary, in oxen at inter-maxillary suture	2·3	...	...	...	2·5	...	...	...	...	...	2·8	2·5	3·7	2·8	0·9	2·3	1·9	...	...
Antero-posterior extent of horncore	8·8	2·3	...	...	...	9·0	6·8	6·8	...	...	7·3	2·8	2·95	3·4	8·0	...	6·0	10·0	...
Circumference of horncore	14·5	...	...	...	...	17·6	13·1	14·0	8·5	...	...	8·0	9·3	9·4	...	...	...	12·55	...
Extent of orbit beyond plane of facial process of maxillary	1·7	1·9	...	...	2·5	...	...	...	...	...	0·35	1·35	1·55	1·5	1·25	1·0	0·95	...	...
Extent of molar series	5·8	...	...	...	...	...	...	...	...	...	5·4	5·7	6·1	6·5	3·8	8·6	3·0	...	...
Length of horn	27·2	14·0	...	...	...	...	...	...	...	10·0	28·6	13·8	...	12·5+	19·5	8·7+	...	...	...
Length of horncore	...	...	...	...	2·9	14·5	11·+	...	7·2	6·5	...	9·5	10·2	8·2	...	...	...	9·0	...
Minimum distance between horncores	...	...	...	...	0·85	0·65	0·5	0·4	1·0	2·2	...	...	...	...	...	...	...	6·0	15·55

* From Inion.

Comparative Measurements of Teeth.

	Molar 3.				Molar 2.			Molar 1.			Premolar 4.			Premolar 3.			Premo. 2.		Canine.		Incisor 3.		Incisor 2.			Incisor 1.		
Upper jaws—	1.	2.	3.	4.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	1.	2.	1.	2.	1.	2.	3.	1.	2.	3.
Musk sheep, British Museum	1·2	0·6	0·49	...	1·15	0·68	0·62	0·9	0·7	0·7	0·76	0·63	...	0·7	0·65	...	0·5	...	...	...	...	...	...	...	...	...	...	...
Bubalus Caffer, ditto	1·1	1·1	1·05	...	1·09	1·08	0·9	0·99	0·95	1·05	0·63	0·9	...	0·75	0·86	...	0·66	0·73	...	...	...	...	...	...	...	...	...	...
Bos taurus, College of Surgeons	1·38	0·9	0·86	...	1·1	0·95	0·9	0·95	0·88	0·8	0·7	0·86	...	0·71	0·71	...	0·64	0·6	...	...	...	...	...	...	...	...	...	...
Bison Europæus, British Museum..	1·28	1·02	0·88	...	1·05	1·07	1·0	0·8	1·06	0·94	...	0·8	0·9	0·7	0·7	...	0·7	0·54	...	...	...	...	...	...	...	...	...	...
Lower jaws—																												
Musk sheep, British Museum	1·6	0·6	0·5	0·32	1·12	0·6	0·58	0·9	0·59	0·57	0·8	0·45	0·41	0·58	0·35	0·35	0·4	0·25	0·3	...	2·9	2·5	0·3	0·28	0·29	2·5	...	...
Bos taurus, College of Surgeons	1·76	0·7	0·68	0·35	1·16	0·72	0·72	0·95	0·6	0·66	0·9	0·5	0·59	0·76	0·41	0·55	0·48	0·35	0·41	0·32	0·35	0·36	0·36	0·4	...	0·4	0·4	...
Bison Europæus, British Museum..	1·78	0·76	0·76	0·42	1·05	0·84	0·8	0·8	0·72	0·75	0·85	0·6	0·6	0·78	0·52	0·55	0·5	0·4	...	...	...	...	...	...	...	...	...	...

Comparative Measurements of Lower Jaws.	Musk Sheep (male), Brit. Mus.	Bison Europæus, Brit. Mus.	B. taurus, Coll. Surg.
Symphysis to condyle	16·5	16·3	17·6
Circumference anterior to premolars ...	3·2	4·75	4·2
Ditto behind last true molar	6·1	6·4	8·0
Symphysis to angle	13·1	14·3	13·0
Height of coronoid process above angle	7·8	8·0	9·7
Length of exterior border of symphysis	1·8	2·6	2·85
Maximum length of condyle	1·2	...	2·25
Breadth of ditto	0·5	...	1·0
Extent of diastema	3·8	4·4	4·8
Length of molar series.....	5·6	6·0	7·5
Depth of jaw anterior to premolars ...	1·4	1·6	1·75
Ditto posterior to last true molar	2·7	2·7	3·46
Symphysis to coronoid process	15·5	16·8	16·5
Angle to condyle	5·1	5·7	7·0
Condyle to top of coronoid process ...	1·6	1·5	2·7

Comparative Measurements of Scapula.	Female Ovibos.	Common Ox.
Maximum length	13·5	17·0
Minimum circumference	5·5	7·8
Transverse measurement of articulation	1·8	2·95
Vertical ditto	2·2	3·2
Heighth of spine above neck	2·0	2·8
Length of spine	10·6	14·8
Length of dorsal edge	7·6	10·0

Comparative Measurements of Pelvis.	Male musk sheep, Sir J. Richardson.	Female musk sheep, Sir J. Richardson.	Musk sheep, Coll. Surg.	Alderney cow.
Distance of the sternal angle of the crest of one ilium to that of the other	13·0	13·5	13·0	18·3
Transverse distance from the same point to the dorsal angle of the same ilium or length of the sterno-dorsal chord of the crest	7·4	7·7	7·3	9·1
Sterno-dorsal diameter of the iliac shaft at its narrowest place	1·5	1·6	1·6	2·0
Sterno-dorsal diameter of the acetabulum	1·9	1·9	1·9	2·1
Atlanto-sacral ditto	2·0	2·0	2·0	2·0
Transverse distance from the apex of one lateral conical process near the dorsal angle of the ischium to the apex of the other (maximum)	8·1	7·8	8·0	11·0
Transverse distance between the dorsal or spinous angles of the ischium, being the width of the pelvis there	4·7	5·0	4·8	8·2
Transverse diameter of the pelvis at the stem or ramus of the ilium	5·4	5·6	5·3	7·1
Length of the foramen ovale	3·6	3·3	3·0	3·6
Sterno-dorsal diameter of ditto	2·6	2·1	2·2	2·3
Length of pelvis from the most proximal angle of the crest of the ilium to the tuberosity of the ischium	18·2	17·2	13·0	19·2
Distance from the pubal brim of pelvis to tuberosity of ischium	7·7	7·0	7·2	9·0
Distance from the dorsal angle of the ischium to the sternal symphysis of that bone	4·4	5·5	6·0	6·1
Distance from the dorsal angle of the ischium to the summit of its lateral conical process	2·0	1·7	1·5	3·2
Sterno-dorsal diameter of the dorsal ramus of the ischium	1·4	1·7	4·7	2·6
Distance from the tuberosity of the ischium to the brim of the acetabulum nearest to it	7·4	6·8	...	8·5
Distance from the atlantal brim of the acetabulum to the sternal corner of the iliac crest	8·0	8·0	8·0	8·8
Length of the proximal ramus of the pubal from the edge of the acetabulum to the symphysis	2·8	3·1	...	3·5

Comparative Measurements of Long Bones.	1.	2.	3.	4.	5.	6.
Humerus—						
Musk sheep, College of Surgeons	12·6	5·2	2·8	3·5	2·8	3·3
Bos taurus, College of Surgeons	13·9	7·3	4·4	5·0	4·9	...
Radius—						
Musk sheep	11·8	4·4	2·8	0·8	...	...
Bos taurus	14·2	6·3	4·0	...	...	...
Ulna—						
Musk sheep	15·2	2·2	...	1·05	0·86	...
Bos taurus	17·3	2·9	...	...	...	...
Metacarpal—						
Musk sheep	6·5	4·8	2·1	1·0	2·6	2·25
Bootherium cavifrons, Leidy	9·65	6·25	3·35	...	3·45	...
,, bombifrons	7·0	3·95	2·35	...	2·5	...
Bos taurus	8·5	7·6	2·8	1·3	2·9	2·7
Phalange 1—						
Musk sheep	2·4	3·0	1·0	0·9	1·1	1·2
Bos taurus	2·3	3·5	1·4	0·9	0·2	0·5
Phalange 2—						
Musk sheep	1·2	3·2	1·3	1·0	1·0	1·8
Bos taurus	1·7	3·7	1·4	1·0	1·2	2·0
Phalange 3—						
Musk sheep	2·5	0·0	0·9	...	...	...
Bos taurus	3·0	1·0	1·5	...	...	...
Femur—						
Musk sheep	14·6	4·7	3·3	2·8	3·2	6·5
Bos taurus	18·8	6·7	5·1	4·8	5·25	9·8
Tibia—						
Musk sheep	12·7	3·8	3·3	2·5	2·1	0·8
Bos taurus	14·2	6·3	4·9	3·8	...	...
Metatarsal—						
Musk sheep	8·0	3·8	1·7	1·6	2·6	2·25
Bos taurus	9·5	4·5	2·2	2·3	2·9	2·6
Hind phalange 1—						
Musk sheep	2·56	2·9	1·08	1·05	1·18	1·4
Bos taurus	2·7	3·7	1·35	1·05	1·25	1·7
Hind phalange 2—						
Musk sheep	1·62	2·8	1·28	0·73	0·9	1·7
Bos taurus	1·95	3·5	1·3	0·94	1·05	2·0
Hind phalange 3—						
Musk sheep	2·15	0·8	0·85	...	...	...
Bos taurus	2·24	...	6·95	1·35	...	...

CHAPTER III.

The Fossil Ovibos.

§ 1. *Fossil Remains in Siberia.*
§ 2. „ „ *America.*
§ 3. *Fossil Remains in Germany.*
§ 4. „ „ *France.*

§ 1. *Fossil Remains in Siberia.*—The fossil remains of Ovibos found in Europe, Asia, and America, are admitted to be specifically identical with the *Ovibos moschatus* by all naturalists conversant with the latter animal. The first notice of the fossil we owe to the great Russian naturalist, Dr. Pallas, who in 1772 described and figured the skulls of two old males[1] (immania cum cornibus capita). The one found on the banks of the Obi, the other from a Tundra, or treeless barren ground, near Beresov, on the same river. He leaves their specific determination open, merely remarking that they agree with *Bubalus Caffer* in the apposition of the horncores. They are, however, recognised by his contemporary in England, Pennant, in 1784,[2] as belonging to the recent Musk Sheep, and as finally affording evidence of the former range of that animal over Northern Asia. In 1809 M. le Comte Rouminatzow found a third head at the embouchement of the Yana, with its horns preserved, and perfect with the exception of its nasals and premaxillaries. M. Ozeretskowsky describes it under the name of Bison Musqué, and believes that the animal lived in Siberia, and that possibly it may have been exterminated by the same intense cold that preserved its bones.[3] His two figures prove that the skull belonged to an old male.

§ 2. *Fossil Remains in America.*—The next discovery of the animal was made by Captain Beechey, in 1826,[4] and subsequently by Captain Kellett, in 1850, in the remarkable accumulation of bones of Mammoth, Reindeer, Elk, Bison, and Horse, originally found by Dr. Eschscholtz in the bay called after his name. They consist of two fragmentary skulls, with horncores of old males, and the atlas, third dorsal, fifth lumbar, and four sacral vertebræ, an acetabulum, pieces of the humerus, and one mutilated tibia. A large cervical vertebra from the same locality is considered by Sir John Richardson to belong

[1] 'Nov. Comm. Petrop.,' xvii, 1772, p. 57.
[2] 'Arctic Quadrupeds,' vol. i.
[3] 'Mémoires de l'Acad. de Pétersb.,' iii, 215.
[4] 'Beechy's Voyage, 4to, Lond., 1831, Appendix.

to a separate species, *Ovibos maximus*, but the differences do not seem to me to be of specific value. The observations of Captain Kellett, Dr. Goodrich, and Dr. Seeman have settled the constitution of the cliffs whence these remains were derived.[1] According to the latter they present the following section:

3. Peat from two to five feet thick; destitute of fossils.
2. Clay, river gravel, loam, and sand, from two to twenty feet, containing trees and fossil bones, and exhaling an ammoniacal odour.
1. Ice from twenty to fifty feet thick.

It is a very singular circumstance that this ancient fluviatile deposit should rest on the surface of a hard crystalline mass of ice which is now gradually melting away.

§ 3. *Fossil Remains in Germany.*—In Germany the animal has been found in four localities. Dr. Baer, in his Inaugural Address in 1823 to the University of Königsberg, mentions the animal, under the name of *Bos Pallasii*, as having been obtained at Neugartenthor, in Prussia. In 1846 the discovery of a skull in the neighbourhood of Merseburg was put on record by Dr. Giebel;[2] and Sir Charles Lyell quotes, in his 'Antiquity of Man,' a skull in the Museum of Berlin correctly named by Professor Quensted[3] as far back as 1836, which had been dug up out of drift in the Kreuzberg, in the southern suburbs of that city. The associated Mammalia are the Horse, Mammoth, and Tichorhine Rhinoceros.[4] The fourth instance of its occurrence in Germany is offered by Professor Schmid of the University of Jena, who describes in the 'Neues Jahrbuch,' for 1863, a portion of a skull found in the preceding year in the ancient alluvium of the Saale.

§ 4. *Fossil Remains in France.*—A tooth found by l'Abbé Laubert in 1859[5] in the gravel of the Oise at Viry-Noureuil, near Chauny, and determined by M. Lartet, was the first indication of the existence of Ovibos in France; it was associated with remains of *Elephas antiquus*, Mammoth, Cave Hyæna, Bear, and Reindeer; flint implements were found in the same bed of gravel. A portion of the skull found in 1859[6] in a gravel pit at Précy, in the same valley, along with a mammoth tusk, and described by M. Lartet, corroborates the truth of his determination. From the same pit a flint instrument of the St. Acheul type was obtained in 1860, and presented by M. de Verneuil to the Geological Society of France. The position of the horncores on the frontals, their small size and rounded section prove that the skull belonged to a female. In the figure appended to M. Lartet's paper the position of the parieto-frontal suture on the coronal surface is very well shown. And lastly, in the year 1864, M. Lartet and Mr. Christy discovered bones

[1] 'Zool. Herald,' p. 1—8.
[2] Leonhard u. Bronn's 'Jahrbuch,' 1846, p. 460.
[3] Ibid., 1836, p. 216.
[4] Lyell, 'Antiq. Man.,' 1863, p 156.
[5] 'Quart. Journ. Geol. Soc. Lond.,' vol. xxi, p. 475.
[6] Comptes Rendus, 1864, lviii, 26.

of the hind limb of the animal in the refuse heap left by the Reindeer folk in the cave of the Gorge d'Enfer, in Périgord, associated with worked flints, lance heads of Reindeer antlers, and bones of the Ox, Horse, and Reindeer. The long marrow-containing bones were split, for the sake of the marrow, just in the same way as those of the other animals used for food.[1] Thus, while in the other two cases cited above there seem no grounds for doubting that the animal coexisted with the Palæolithic savages in France, there can be no doubt whatever of its having been used for food by the Reindeer folk of Auvergne.

[1] 'Quart. Journ. Geol. Soc.,' vol. xxi, p. 475, *note*.

CHAPTER IV.

FOSSIL OVIBOS IN GREAT BRITAIN.

Pls. I, II, III, IV, V.

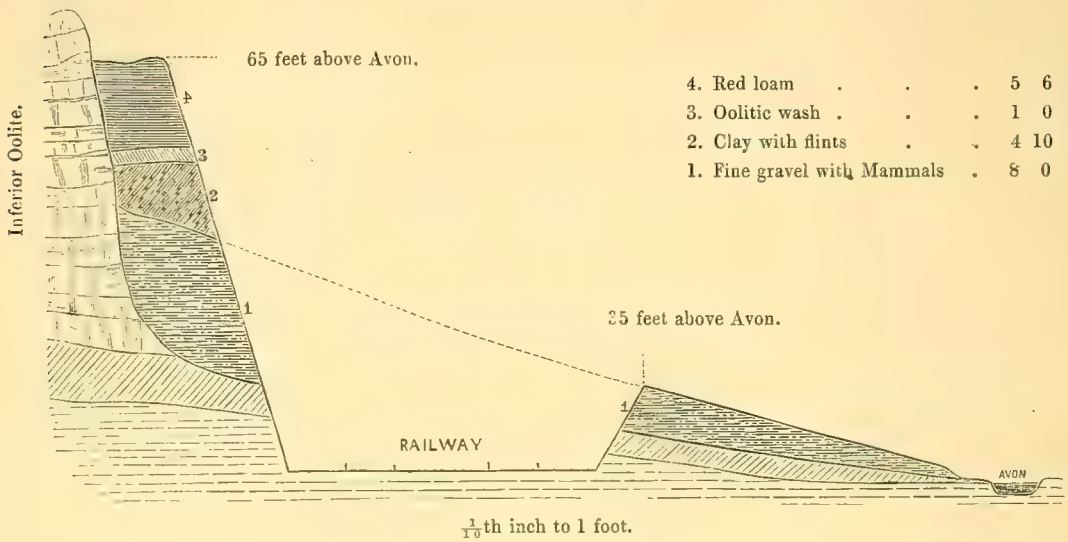
§. 1 *Remains found at Maidenhead and Green-street Green.*
§ 2. *Remains found at Freshford.*
§ 3. „ „ *Barnwood.*
§ 4. *Remains found at Salisbury.*
§ 5. „ „ *Crayford.*
§ 6. *The age of the deposit at Crayford.*
§ 7. *Range in space and time of Ovibos.*

§ 1. *Remains found at Crayford and Green Street Green.*—We owe to the Rev. Charles Kingsley and to Sir John Lubbock the first proof of the animal having lived in Britain: and the skull which they discovered in the low-level Thames gravel near Maidenhead in 1855, is described under the name of *Bubalus moschatus*[1] by Professor Owen, who was probably misled by a hint of Dr. Pallas as to its affinities with the Cape Buffalo. It belonged to an adult male of rather small size; and, as it is very much broken, the position of the parieto-frontal suture, nearly in the middle of the horncores, is very well shown on the cranial surface. Sir John Lubbock has also been fortunate enough to find a fragmentary skull of a male in the gravels of Green Street Green, near Bromley in Kent, associated with the remains of Bison. Its condition proves that it has been exposed for some time to the attrition of the fluviatile sand and gravel in which it lay. These two skulls are preserved in the British Museum along with those from Eschscholtz Bay.

§ 2. *Remains found at Freshford.*—In the West of England two very well preserved fragments of the skulls of a male and female, Pl. V, fig. 1, have been found by Mr. Charles Moore in the gravels of the Avon at Freshford, near Bath. The remains of other animals which I have seen from the same place belong to the Mammoth, Bison, Horse, and Reindeer. In 1866 I examined the locality along with the Rev. H. H. Winwood, F.G.S. In the narrow valley which the river Avon has cut through the Bath and Lower Oolites, into the sands below, are patches of gravel at different heights above the present stream.

[1] 'Brit. Assoc. Rep.,' 1856, 'Trans. Sect.,' p. 72.

The section exposed near the Freshford Railway-station from which the Musk Sheep were obtained, presents a lenticular mass of gravel consisting of waterworn pebbles of Mountain-limestone, flint, chert, Oolite, hornstone, quartzite, Old Red Sandstone and fossil shells from the adjacent beds; resting on the Lower Oolite limestones at the bottom, are a



few big boulders, and the pebbles are larger there than in the upper or middle part. The whole bed is highly confused, and presents none of the sorting action which would be the result of pebbles transported by a river flowing under temperate conditions. It could indeed only have been deposited by an ice-burdened river, under severe climatal conditions.

The list of animals derived from it leads to the same conclusion; for two out of the five, the Reindeer and the Musk Sheep,[1] are found now only under an arctic climate, and all the species occur in the frozen cliff in Eschscholtz Bay. I have not the slightest doubt that the fluviatile ossiferous deposits in both these localities were formed under similar conditions, with this difference only, that the climatal change has only advanced so far in Kotzebue Sound as to gradually melt the ice cliffs, and thus to cause the coast-line mapped by Admiral Kotzebue to become lower, and in every respect much changed during the last eighty years, while in Somersetshire the arctic conditions have entirely passed away.

The preceding section shows the exact relation of the gravel to the beds above, which are probably rain-wash of different ages. They all abut against the oolitic limestone, which appears at the surface at a slight distance above the cutting.[2]

[1] Compare Beechey Voyage, Appendix by Dr. Buckland, with 'Zool. H. M. S. Herald,' p. 1—8.

[2] For the heights which prove that the gravel belongs to the low-level series of Mr. Prestwich, F.R.S., I am indebted to the Rev. H. H. Winwood.

The low-level gravels of Loxbrook, also near Bath, which possibly may be of the same date as those of Freshford, have afforded remains of Cave Lion, Irish Elk, Mammoth, and Tichorhine Rhinoceros.

The absence of the Musk Sheep from the bone caverns of this district, from which such vast stores of remains have been obtained, at Banwell, Bleadon, Durdham Down, Uphill, Hutton, Sandford Hill, Burrington, and especially Wookey Hole, does not prove that they have no relation to the river bed of Freshford. The Bison, Mammoth, Reindeer, or Horse, associated with the Musk Sheep, have been found in all those caverns, and therefore I think it very probable that they were open while the latter animal was ranging on the banks of the Avon, and that its rarity was the cause of its not having been yet discovered in the caves.

§ 3. *Remains found at Barnwood.*—A fourth case of the discovery of this rare animal in Britain is afforded by the basal portion of a skull obtained from the gravel of Barnwood, near Gloucester, by Mr. Lucy,[1] to whose admirable essay on the gravels of the Severn I would refer for an account of the section. The squareness of the area included between the anterior and posterior impressions for the attachment of the cervical muscles (Pl. I, fig. *c*, *d*) show at once that the animal to which it belonged was ovine or caprine, and its large size that it belonged to *Ovibos moschatus*. It measures 1·45 inches from the anterior to the posterior cervical impression, 3·2 across the posterior, and 2·45 across the anterior cervical impression. Among the other remains found in the same place I was able to identify those of the Mammoth and the Woolly Rhinoceros. Nor were these the only animals with which the Musk Sheep dwelt in the district; other gravel beds of the same geological age at Eckington, Cropthorne, Pershore, Stroud, Beckford, Fladbury, Worcester, Upton, and Tull Court, have furnished the following species:

Hippopotamus major	*Cervus elaphus.*
Elephas antiquus	„ *tarandus.*
Bos primigenius	*Equus caballus.*
Bison priscus	*Sus scrofa ferus.*

§ 4. *Remains found at Salisbury.*—The fifth discovery of the Ovibos in Great Britain, we owe to the labours of Dr. Blackmore, of Salisbury. Among the mammalian remains from the low-level gravels of Fisherton, he detected a nasal bone, a tibia, and an astragalus, which belonged to this arctic mammal.[2] They were associated with the remains of the following animals:

[1] 'The Gravels of the Severn, Avon, and Evenlode,' by W. C. Lucy, Cotteswold Club, Gloucester, April 7, 1869, p. 18.

[2] Stevens, 'Flint Chips,' 8vo, 1870, p. 16 and p. 30.

Felis spelæa.	*Elephas primigenius.*
Hyæna spelæa.	*Equus caballus.*
Canis lupus.	*Rhinoceros tichorhinus.*
Bison priscus.	*Sus crofa.*
Bos primigenius.	*Spermophilus.*
Cervus elaphus.	*Lemmus.*
,, *tarandus.*	*Lepus timidus.*

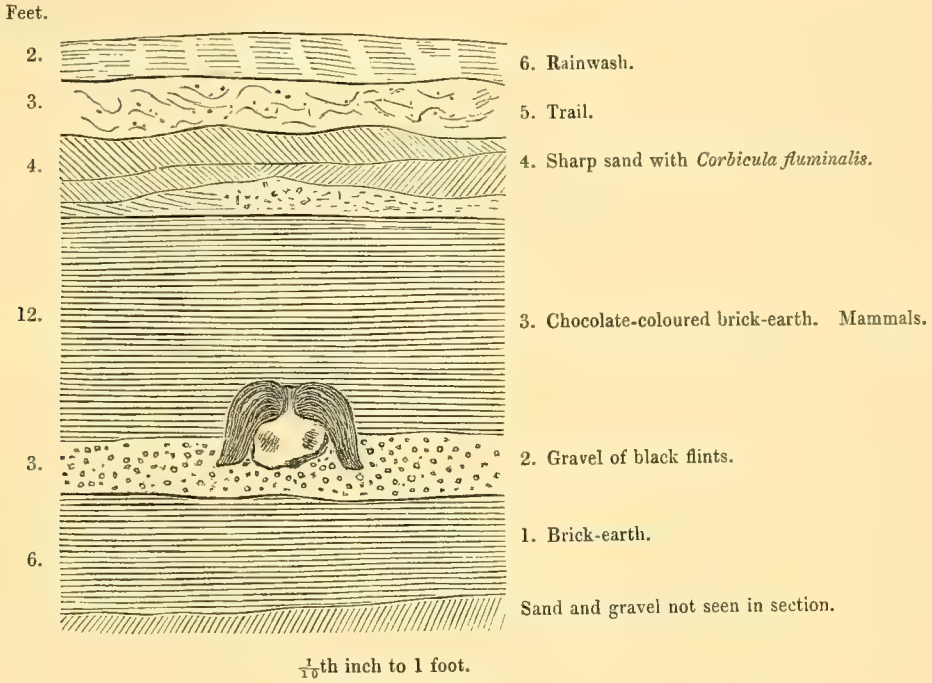
There were also in the same deposit many land and fresh-water shells, all of which still live in the neighbourhood, except *Succinea oblonga*.[1]

§ 5. *Remains found at Crayford.*—All the foregoing instances of the occurrence of Ovibos in the South of England prove that the animal lived there during a comparatively modern period, speaking in a geological sense. The beds from which they were derived are in several cases but a few feet above the level of the streams, and the associated animals are of species which are known to have existed during a late division of the Pleistocene period. That the animal dates back from a higher antiquity in Britain, at least, is proved by my discovery of a remarkably fine head in the lower brick-earths of the Thames Valley,[1] at Crayford in Kent. In November, 1866, I visited the pit in company with Mr. Flaxman Spurrell, and was fortunate enough to find, and convey safely to the Museum of the Geological Survey in London, the cranium of a fine Bull, with its two horn-cores absolutely perfect. The whole of the facial portion, including the maxillary and palatines, is wanting; the mastoids, paramastoids, and lambdoid crest, are also broken. As we dug it out of the matrix the fragmentary condition cannot be ascribed to the carelessness of the workmen. In its present state, however, it is more perfect than any other found in Britain, and enough is left to put its determination beyond all doubt. The basi-occipital bone (Pl. I, fig. 1) is remarkable for the stoutness of the muscular impressions, and for the squareness of the area which they define. The anterior pair (*c*) are long and narrow, and advance obliquely forwards until a small groove in the median line prevents them from meeting. The suture between the basi- and presphenoidal suture is well marked, and the presphenoid itself is overlapped by a fragment of the former. Enough of the pterygoid remains to demonstrate its ovine affinities in the wide angle it makes with the basi- and presphenoid. The height of the foramen magnum (Pl. II *a*, 1·22), is the same as its breadth. On the occiput the nuchal space is well seen, and the two impressions for the cervical muscles are very deep. The occipital ridge above them is broken away. The occipito-parietal suture is very well shown on the coronal surface. The spongy bases of the horncores do not extend as far back as the occiput, and are separated from one another in the middle by an interspace of 0·65 inches. The horncores

[1] 'Quart. Journ.,' vol. xx, p. 192; also Stevens, 'Flint Chips,' 8vo, 1870, p. 30.

themselves agree exactly with those of the recent animal, and their description therefore would be superfluous. At a distance of 1·8 inches from the horncores a ridge runs across the frontals, from the roof of one orbit to the other, and is much more pronounced than in any of the skulls of the existing Musk Sheep. A reference to the Table of skull measure-

Section. North side of Stoneham's Pit, Crayford, with skull of Ovibos moschatus.



$\frac{1}{10}$th inch to 1 foot.

ments will show (p. 12) that this skull surpasses in size any of those which are recorded of the living or fossil animal. The exact position in which it was found is shown in the preceding section, taken on the north side of an old working, and not very far from the Manager's Office.

This section agrees essentially with that taken at some distance off, and published in my paper on the Lower Brick-earths of the Thames Valley.[1] No. 3, which furnished the head, is the principal mammaliferous bed in the pit. The lists of mammalia and shells obtained out of the same pit, and preserved in the collections of Mr. Grantham and Dr. Spurrell, are reproduced, because of their peculiar value in relation to the presence of the Musk Sheep.

[1] 'Quart. Journ. Geol. Soc.,' vol. xxiii, p. 96.

Freshwater Species.

Corbicula fluminalis.	*Planorbis carinatus*, Müll.
Cyclas cornea, L.	„ *corneus*, Drap.
Pisidium amnicum, Müll.	*Paludina vivipara*, Gray.
Unio litoralis, Drap.	„ *tentaculata*, Lin.
Anodon cygneus, Mont.	*Ancylus fluviatilis*, Möle.
Limnæa peregra, Lam.	*Valvata piscinalis*, Müll.
„ *stagnalis*, L.	

Terrestrial Species.

Helix nemoralis, Müll.	*Pupa marginata*, Drap.
„ *caperata*, Mont.	*Carychium minimum*, Müll.

Fossil Mammalia.

Homo.[1]

Felis spelæa, Gold.	*Cervus elaphus*, Linn.
Hyæna spelæa „	*Elephas antiquus*, Falc.
Ursus ferox, Linn.	„ *primigenius*, Blum.
„ *arctos* „	*Equus fossilis*, Ow.
Canis lupus „	*Rhinoceros tichorinus*, Cuv.
Bos primigenius, Boj.	„ *hemitœchus*, Falc.
Bison priscus, Ow.	„ *megarhinus*, Christ.
Megaceros Hibernicus, Ow.	*Arvicola amphibia*, Desm.

Thus, in addition to the ordinary freshwater and land shells, and the ordinary Pleistocene Mammalia, the Musk Sheep in these beds is associated with *Rhinoceros hemitœchus*, *R. megarhinus*, and *E. antiquus*. In my essay before alluded to, I have shown that the group of deposits to which these strata belong is of an age intermediate between the preglacial forest-bed of the Norfolk shore, and the river deposits, which are later than the Boulder-clay in the centre and east of England. Basing my argument on the physical evidence, and on the presence of Pleiocene forms of life, and on the absence of the whole group of arctic mammals, and especially of the Reindeer, which is most abundant in the ordinary Pleistocene river gravels, I came to the conclusion, that the climate under which the lower Brick-earths of the Thames Valley was accumulated was temperate rather than severe. Nor is this conclusion invalidated by the subsequent discovery of the most

[1] Since this was written the Rev. O. Fisher discovered an unmistakably artificial flint flate in the undisturbed section, in the presence of the Author, April 9, 1872.

arctic of known living mammalia, the Musk Sheep, since the evidence which it offers must be weighed against that offered by the other mammalia. And among these, that of the Mammoth and Woolly Rhinoceros must be put out of court, because the first possessed a sufficiently elastic constitution to endure the severity of a Siberian climate, and to flourish alike in Italy and in the southern states; and it is very probable, from the wide range of the latter, that it had similar capacities of enduring climatal extremes. Either the Musk Sheep must have wandered into the temperate regions at the time, or the associated animals must have been fitted to endure the severity of a climate in which the Musk Sheep now lives. The former alternative seems to me to be far more likely to be true than the latter. I should be inclined to consider that the skull in question belonged to an animal that had strayed from its usual arctic haunts in the winter, southwards into the country more usually occupied by the animals with which it was found, and this view is considerably strengthened by an appeal to like cases of migration at the present day.

In North America, for example, the Bison ranged, in Hearne's time, over the open rushy plains as far to the north and east as the southern shore of Athabasca Lake in lat. 59°, while on the colder shores of Hudson's Bay, a little to the north of Fort Churchill in the same latitude, that explorer found proofs of the presence of Musk Sheep. In an unusually severe winter there would be nothing extraordinary in the latter animal occasionally straying south of Athabasca Lake, and its bones being mingled with those of the Elk, Waipiti, and Bison. I should therefore view this isolated case of the occurrence of the most arctic of all the ruminants on the banks of the Thames, during the time of the deposits of the Lower Brick-earths, as altogether exceptional, and not affecting the sum of the evidence as to climate afforded by *Rhinoceros megarhinus*, *R. hemitœchus*, *Cervus elaphus*, *C. capreolus*, *Elephas antiquus*, *Hippopotamus major*, and indeed all the other mammalia of the group found at Ilford, Gray's Thurrock, or Erith.

§ 6. *The Age of the Deposit at Crayford.*—The relation of the lower Brick-earths to the Glacial period, under which name are comprehended the complex phenomena offered by—1, the development of an ice sheet like that of Greenland; 2, the submergence of the land beneath the sea; 3, the glacier period, is one of those difficult and delicate questions which cannot be solved definitely in the present state of our knowledge. There are, however, two considerations which are of considerable value in coming to any conclusion whatever. In the first place we know, that the mammalia inhabiting the English side of the great valley of the North Sea in Pleiocene times, lived under a temperate climate; and it is only reasonable to suppose that, as the temperature became lowered in the northern regions, the northern animals would gradually pass southwards, and occupy the feeding grounds, which had been before those of the animals inhabiting the temperate zone. This must have taken place at the very beginning of the Glacial period in Great Britain, for the lowering of the temperature which dispossessed them of their ancient

feeding grounds in Northern Europe and Asia, gradually passed southwards, until at last it reached its maximum, at the time when Scandinavia, Great Britain, and Ireland, lay buried under an enormous ice-sheet. The mixed character of the mammalia of the Lower Brick-earths is just what might have been expected from any such migration as this. The remains of the Pleistocene species, the Mammoth, Woolly Rhinoceros, and Cave Lion, are quite as abundant as those of the Pleiocene *R. hemitœchus*, *R. megarhinus*, and *Elephas antiquus*, and prove that the former animals were in joint occupation of the region at the time, and that the Pleiocene animals were still in competition with the new comers in the district; and that the latter should have been followed in the course of time by a stray Musk Sheep is not at all to be wondered at. On this view, the Lower Brick-earths of the Thames Valley may be ascribed, with tolerable certainty, to the age when the temperature was gradually becoming lowered, towards the beginning of the Glacial period, rather than to that during which vast herds of Reindeer lived on the site of London, and at Windsor, while the gravels were being accumulated, which are proved by the foreign pebbles, which they contain, to be posterior in date to the submergence of central and northern Britain beneath the waves of the sea. During this later period the evidence is conclusive, that the arctic division of the Pleistocene mammalia,—the Reindeer, Glutton, Musk Sheep, Marmot, and Spermophilus, had firm hold on the country, and the Reindeer ranged over the whole of Great Britain, which was free from glaciers, only comparable in number to the great migratory bands now living in northern Siberia. Had the Lower Brick-earths of the Thames Valley been deposited at this time, the Reindeer could hardly have failed to have been represented in the large collections of mammalia from Ilford, Crayford, Erith, and Grays Thurrock, since it is so abundant in the river deposits higher up the valley of the Thames. They must therefore be earlier or later in geological age; and from the facts which I have brought forward, it seems to me that they must be earlier, or before the maximum amount of cold was reached in the Glacial period in Great Britain.

This view of the high antiquity of the Lower Brick-earths in the Thames Valley, is not held by the great authority on river deposits, Mr. Prestwich,[1] who believes, because of their slight elevation above the present level of the Thames, they must belong to a late division of the Post-pleiocene, or Pleistocene age. There seem to me, however, to be insuperable objections to the view that, in every case, the level will give the relative age of the deposit. It is certain that, if all the superficial deposits in a given valley, say the valley of the Thames, had been left by the ancient representatives of the present rivers, at different levels above their present courses, those levels will give the relative antiquity of the beds of sand or gravel in question, *provided that the land has remained stationary.* The extent to which the valley is cut down will give a rough sort of idea of the lapse of past time. But if the land were elevated in one place, and depressed in another, as we are

[1] Prestwich, 'Geol. Mag.,' vol. i, p. 245.

bound to admit to be the case throughout all past time, then the evidence of relative levels is not decisive. What are now low-level deposits, may, in some cases, be of the same antiquity as those at higher levels, owing to movements in the earth's crust since they were deposited. Or again, if we suppose a valley with a river flowing through it, to be depressed beneath the surface of the sea, the higher marine may yet be younger than the lower fluviatile deposit, as in the case of the forest-bed on the Norfolk shore, on which rest marine sands and gravels, and boulder clay, which have been deposited after its submergence. Unless, therefore, in any particular case, there be no oscillations of level, and unless there can be no interference by the sea with the cutting-down action of the river, relative height is no standard of age. No proof of either of these conditions, necessary to the truth of Mr. Prestwich's view, is to be found in the lower part of the Thames Valley. On the contrary, since during the glacial epoch Scotland,[1] according to Sir Charles Lyell, was depressed to a depth of two thousand feet beneath the sea, and the hills of Wales to a still greater depth according to Professor Ramsay,[2] it seems to be incredible that the Thames Valley should not have shared, in some degree, in this depression. Whether or not the true boulder clay was ever deposited in the Thames Valley proper, is an open question; but the fact that it occupies the basin of the Roding, the affluent to the Thames, as well as those of the two rivers immediately to the north, the Blackwater and the Colne, proves that the main features of the country were sketched out before the boulder clay age, and that it also was excavated in Preglacial times. It appears therefore to me that, in this case, the evidence offered by the low-lying position of the strata is valueless as compared with that offered by the mammalia in favour of the high antiquity. Were the test of level to be applied to the forest-bed, it might be shown likewise to be of late Pleistocene age, had it not been for the accident of the boulder clay being above. And if this had been denuded away, we should merely have had the mammalia to show the true geological age of the deposit in which they were found.

§ 7. *The Range in Space and Time of Ovibos Moschatus.*—We have now quoted all the localities on record in which the remains of fossil *Ovibos* have been found. During the Pleistocene age, it ranged over northern Siberia and the plains of Germany and France, occurring very generally in the river deposits along with Reindeer, Mammoth, and Woolly Rhinoceros. In England four out of five cases of its occurrence are in ordinary Pleistocene gravels, while the fifth relegates it to a more ancient date, in which Pleiocene mammalia lived, side by side, in the valley of the Thames, with those that are characteristic of the Pleistocene period. That the animal was very rare in the Postglacial deposits in Europe is proved by its having been found in only ten places. In Siberia, although only three instances are on record of its having been found, it is probably abun-

[1] Lyell, 'Antiquity of Man.'

[2] Ramsay, 'Quart. Geol. Journ.,' 1851, p. 372.

dant in the vast unexplored stores of remains in the frozen gravel of the Tundras, and especially at Sviatoi Ness. Its rarity would imply that its head-quarters were in some district to the north and east of France and Germany in the Pleistocene period, and that it only inhabited the districts in which it is found in an unusually severe season, which would drive it from its usual haunts. We have thus traced the *Ovibos moschatus* far to the east and south of its present habitat. It coexisted with the Mammoth and the Reindeer in Eschscholtz Bay, and with that animal and the Tichorhine Rhinoceros it ranged throughout Siberia, Germany, and as far south as the valley of the Avon in Somersetshire and Périgord in France, or more than 15° south of its present southern limit in America.

CHAPTER V.

Conclusion.

§ 1. *Comparison between Ovibos and Bootherium.* | § 2. *General Conclusions.*

§ 1. *Comparison between Ovibos and Bootherium.*—The researches of Dr. Leidy[1] have proved the existence in America of a fossil animal, which he recognises as intermediate in character between *Ovis* and *Bos*, and for which, in 1852, he proposed the name of *Bootherium* (Pl. V, figs. 2, 3, 4). In his magnificent work, however, on the 'Mammalian Remains of North America,' published in 1869,[2] he admits that the fossils probably belong to the genus *Ovibos*, a conclusion which I brought before the Royal Society in 1867, and printed in abstract in the 'Proceedings' (vol. xv, p. 516). The type of his genus consists of two crania, the one from ferruginous gravel near Fort Gibson on the river Arkansas, the other from the morasses of Big Bonelick. The former of these, from the admirable figures and description, clearly possesses all the characters of male *Ovibos*, with this exception, that the bases of the horncores coalesce in the median line, and advance further forward than a line connecting the anterior edges of the orbits together, and thus almost completely covering both frontals and parietals. The horncores springing from this elongated bone, at a distance of four inches behind the anterior portion, are flattened on the top, as in male *Ovibos*, but their antero-posterior diameter is not so great, nor is the downward direction so decided. From the analogous case of the horn-development in *Ovibos*, I should infer that this cranium belonged to an old male. From the flatness and excavation of the horncores Dr. Leidy terms it *Bootherium cavifrons* (Pl. V, fig. 2). The second skull (fig. 3), which is the more perfect of the two in respect of its horncores, bears exactly the same relation to that of *B. cavifrons*, as the male to the female Musk Sheep. They are more cylindrical, smaller, and supported by the frontals. It is therefore highly probable that *B. cavifrons* and *B. bombifrons* are the male and female of the same species. As the lachrymal region is preserved in the second, there is evidence of a broad and deep lachrymal fossa in front of the orbit, which in its depth resembles that presented by

[1] Leidy, 'Smithsonian Contrib. to Knowledge,' vol. v, art. 3, "On the Extinct Species of American Ox," 1852.

[2] 'Journal of the Academy of Natural Sciences of Philadelphia,' 2nd series, vol. vii, 1869, p. 374.

Caprovis Vignei, or the *Argali* of Ladak (Coll. Surg. 3778). It is, however, also paralleled by that in a skull of an old male *Ovibos* in the College of Surgeons (3814). The direction of its horncores is downwards and forwards. In all other respects both these skulls so closely resemble *Ovibos moschatus*, that were it not for the points noted above, I should believe that they belonged to that animal. Beyond all doubt they represent a closely allied species of the same genus *Ovibos*.

§ 2. *General Conclusions*.—In this Essay I have brought forward the evidence in favour of the following conclusions: first, that *Ovibos* was rightly classified by De Blainville with the *Ovidæ*, and not with the *Bovidæ;* secondly, that it has no classificatory relationship with *Bubalus Caffer*, as Professor Owen maintains, both in his original article and in the 'Anatomy of the Vertebrates.' And lastly, that it has a greater range in time than was suspected, having been a contemporary with the Megarhine Rhinoceros during the early portion of the Pleistocene period, when the Lower Brick-earths were being deposited in the valley of the Thames.

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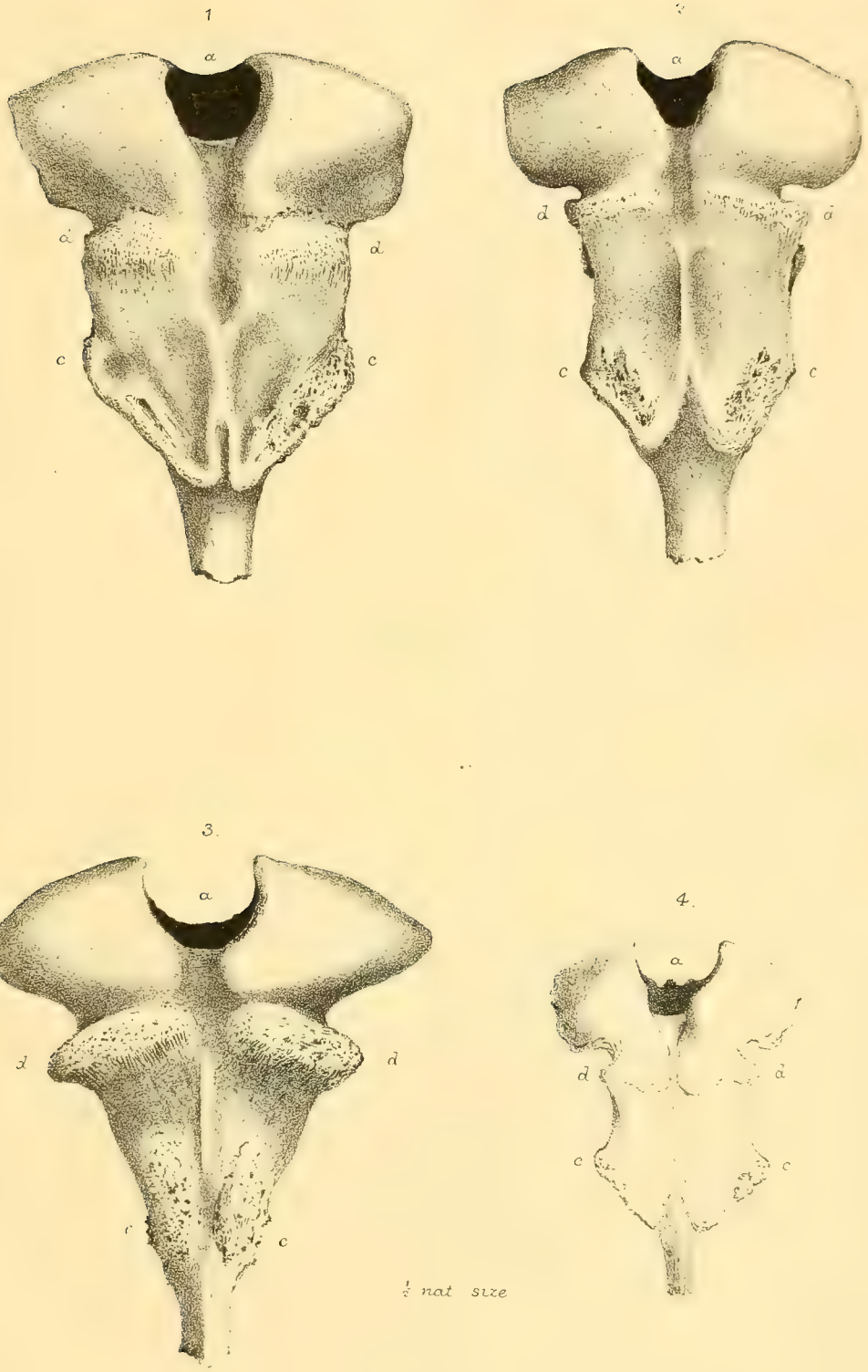
PLATES I, II, III, IV, V.

PLATE I.

Ovibos moschatus, Blainville.

Fig.

1. Basi-occipital of *Ovibos moschatus*, from the Lower Brickearths, Crayford, Kent. In the Museum of the Geological Survey.
2. Basi-occipital of *Ovibos moschatus*, North America. British Museum.
3. Basi-occipital *Bubalus caffer*. British Museum.
4. Basi-occipital of *Argali*, *Caprovis Argali* of Ladak. British Museum.



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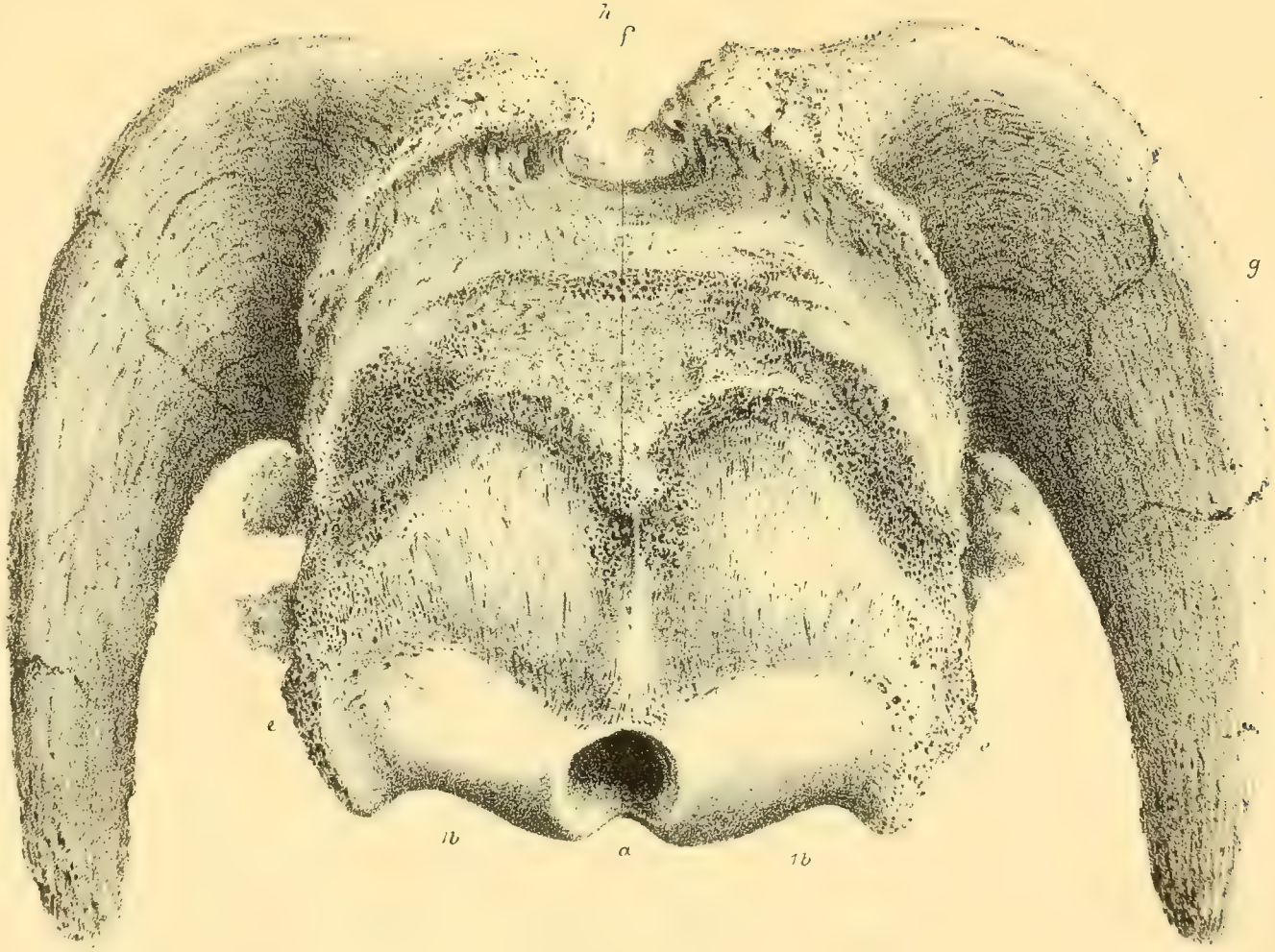
1. 2. BASIOCCIPITAL OF OVIBOS. 3. BUBALUS CAFFER.
4. CAPROVIS ARGALI.

PLATE II.

Ovibos moschatus, Blainville.

Occipital view of skull from the Lower Brickearths, Crayford, Kent. In the Museum of the Geological Survey.

a. Foramen magnum.
b. Condyles.
e. Paramastoid process.
f. Nuchal spine.
g. Horncore.
h. Coronal interspace.



OCCIPITAL VIEW OF SKULL OF OVIBOS MOSCHATUS

PLATE III.

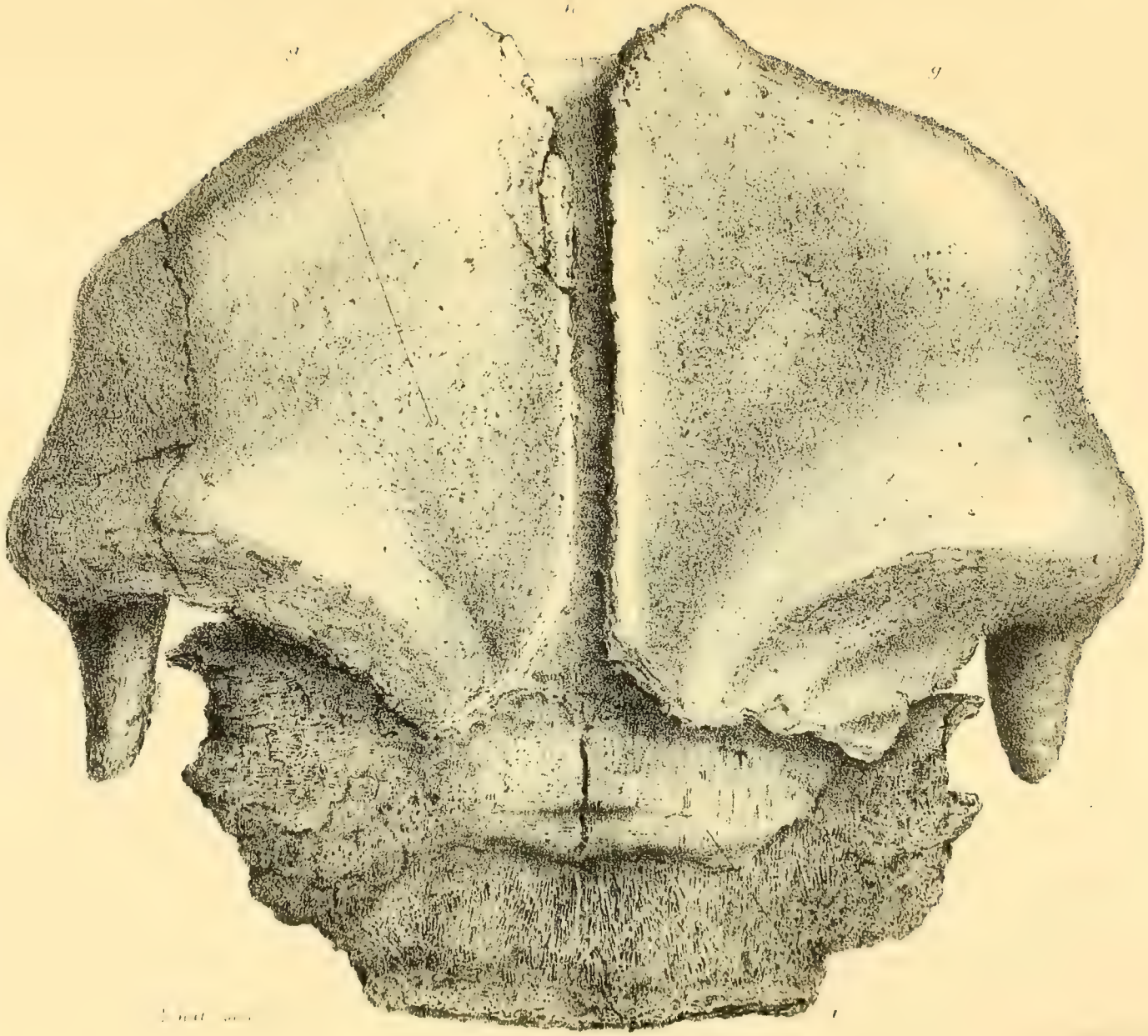
Ovibos moschatus, Blainville.

Coronal view of skull, from the Lower Brickearths, Crayford, Kent. In the Museum of the Geological Survey, figured Pl. II; and Pl. IV.

g. Horncores.

h. Coronal interspace.

i. Transverse ridge on frontals.

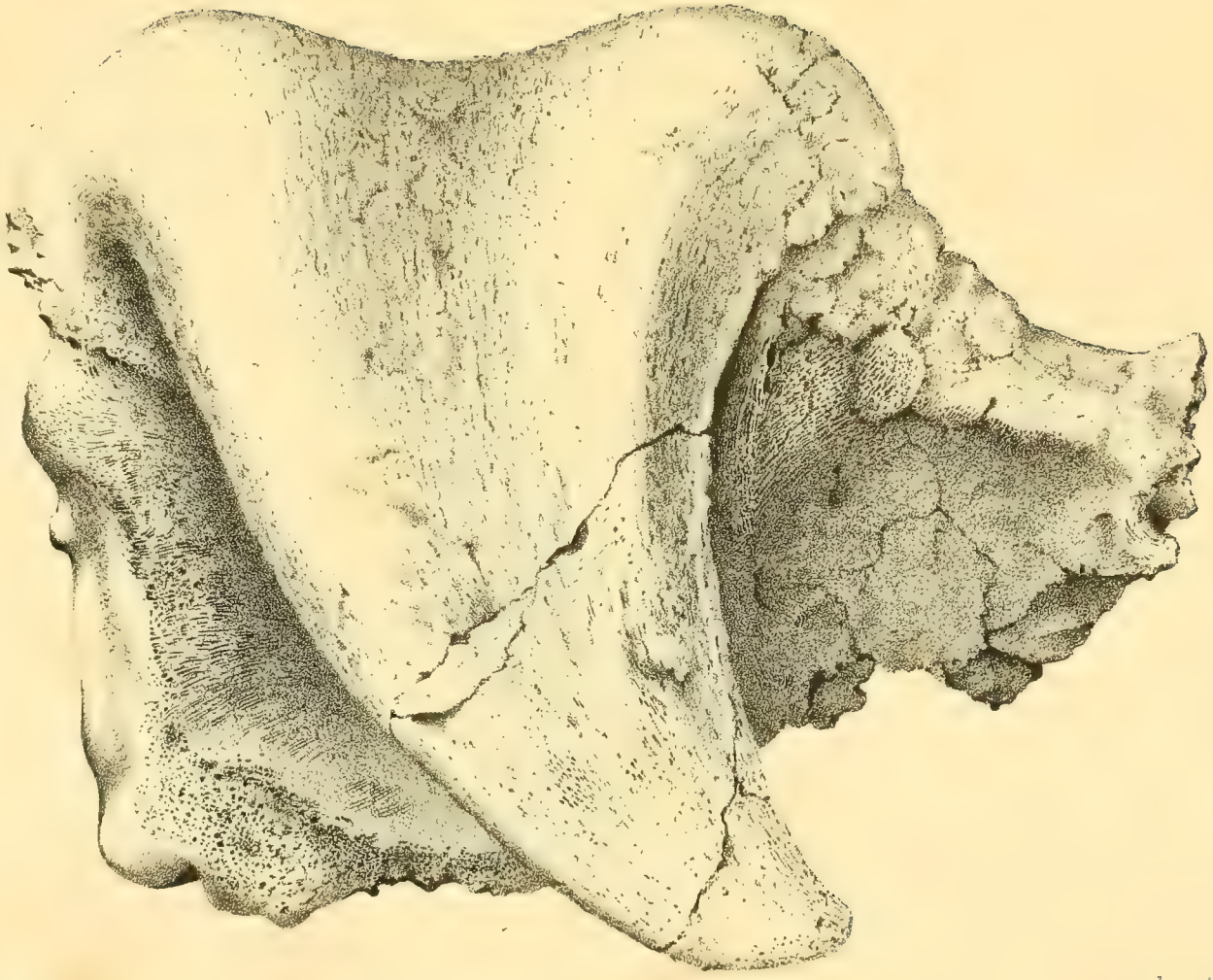


CORONAL ASPECT OF SKULL OF OVIBOS MOSCHATUS

PLATE IV.

Ovibos moschatus, Blainville.

Lateral view of skull, from the Lower Brickearths, Crayford, Kent. In the Museum of the Geological Survey, figured Pls. II, III.



$\frac{1}{2}$ *nat. Size*

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SIDE VIEW OF OVIBOS MOSCHATUS

PLATE V.

Ovibos.

Fig.

1. Coronal view of skull of female Musk Sheep, *Ovibos moschatus*, from the Pleistocene gravel of Freshford, near Bath, Somerset. In the Collection of Charles Moore, Esq., F.G.S.

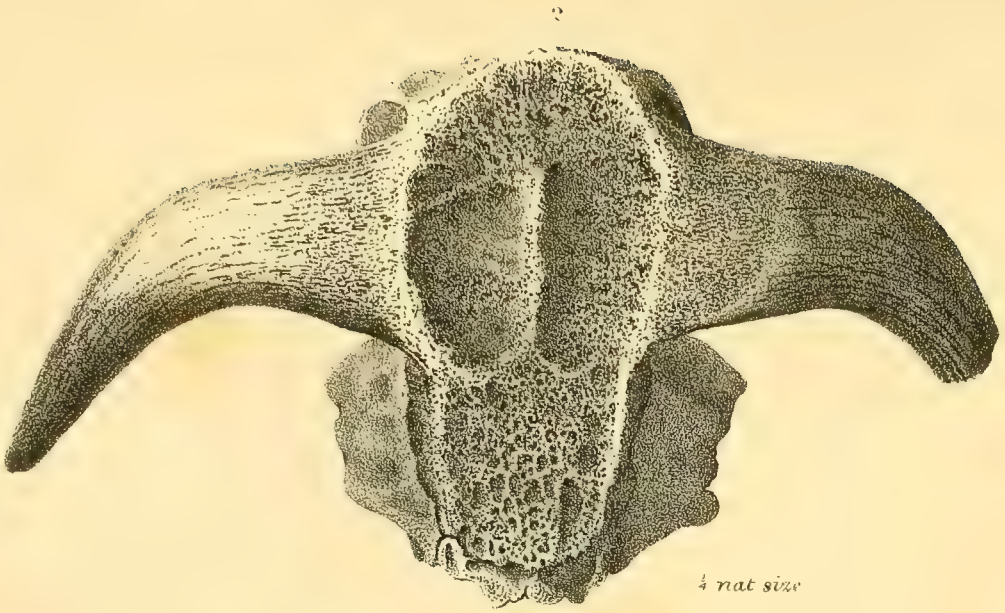
   g. Horncore.

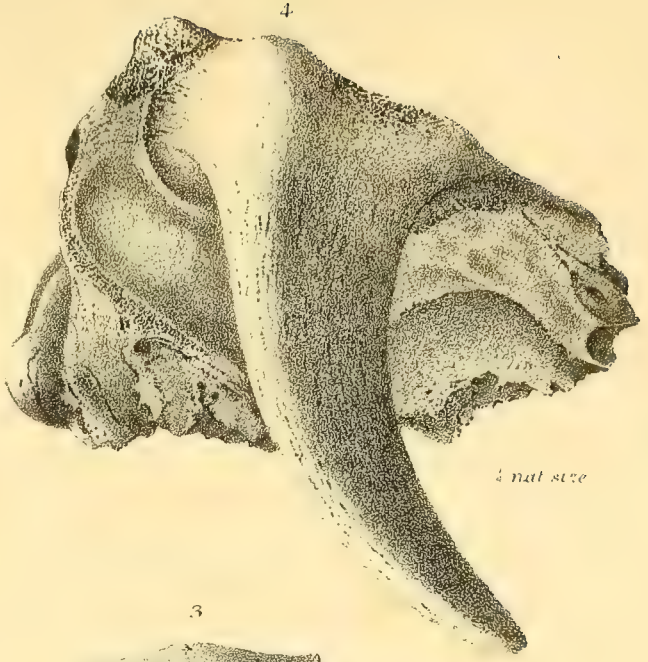
   h. Coronal interspace.

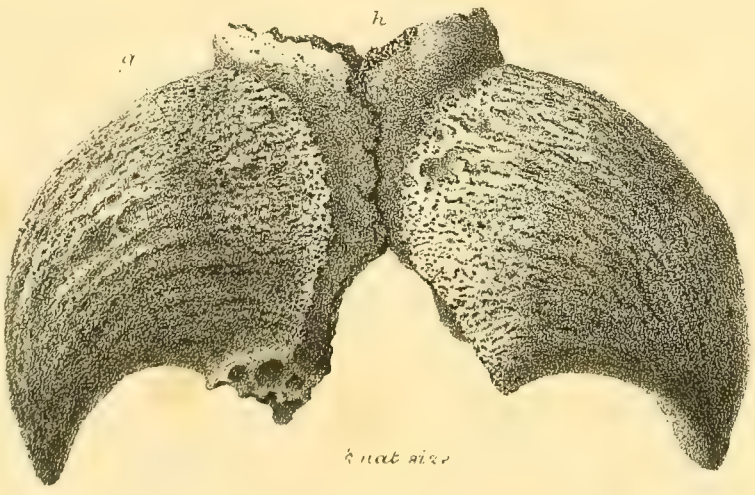
2. Coronal view of skull of *Ovibos cavifrons*, Leidy; old male, from gravel near Fort Gibson, Arkansas. After Leidy, 'Smithsonian Contributions,' September, 1852, pl. iii, fig. 1.

3. Coronal view of skull of *Ovibos cavifrons*, *Bootherium bombifrons*, Leidy; adult female, from Big-bone Lick. After Leidy, op. cit., pl. iv, fig. 2.

4. Lateral view of skull of *Ovibos cavifrons;* adult female, from Big-bone Lick. After Leidy, op. cit., pl. iv, fig. 1.







J Dinkel lith

1. OVIBOS MOSCHATUS 2. OVIBOS CAVIFRONS, MALE

3 – 4. OVIBOS CAVIFRONS, FEMALE

J. Smit & Co imp

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